Durability and Wood Protection
Research Work Unit FS-FPL-4723

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Biofuels Advanced Energy Initiative
Thermo-Conversion of Woody Biomass

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Forest Products Laboratory

Our mission

We use science and technology to conserve and extend our Nation's forest resources. For almost 100 years, our mission has been to use our Nation's wood resources wisely and efficiently, while at the same time keeping our forests healthy. Many breakthrough technologies that influence the way we live started at the Forest Products Laboratory (FPL).

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Our role and experience

Established in 1910 by the U.S. Department of Agriculture Forest Service, the FPL in Madison, Wisconsin, serves the public as the Nation's leading wood research institute. The FPL is recognized both nationally and internationally as an unbiased technical authority on wood science and use. Our research is concentrated in one location to promote an interdisciplinary approach to problem solving. The FPL cooperates with many universities, industries, and federal and state agencies.

Our areas of expertise

Today, more than 184 scientists and support staff conduct research on expanded and diverse aspects of wood use. Research concentrates on pulp and paper products, housing and structural uses of wood, wood preservation, wood and fungi identification, and finishing and restoration of wood products.

In addition to traditional lines of research, FPL is responding to environmental pressures on the forest resource by using cutting-edge techniques to meet important future challenges:

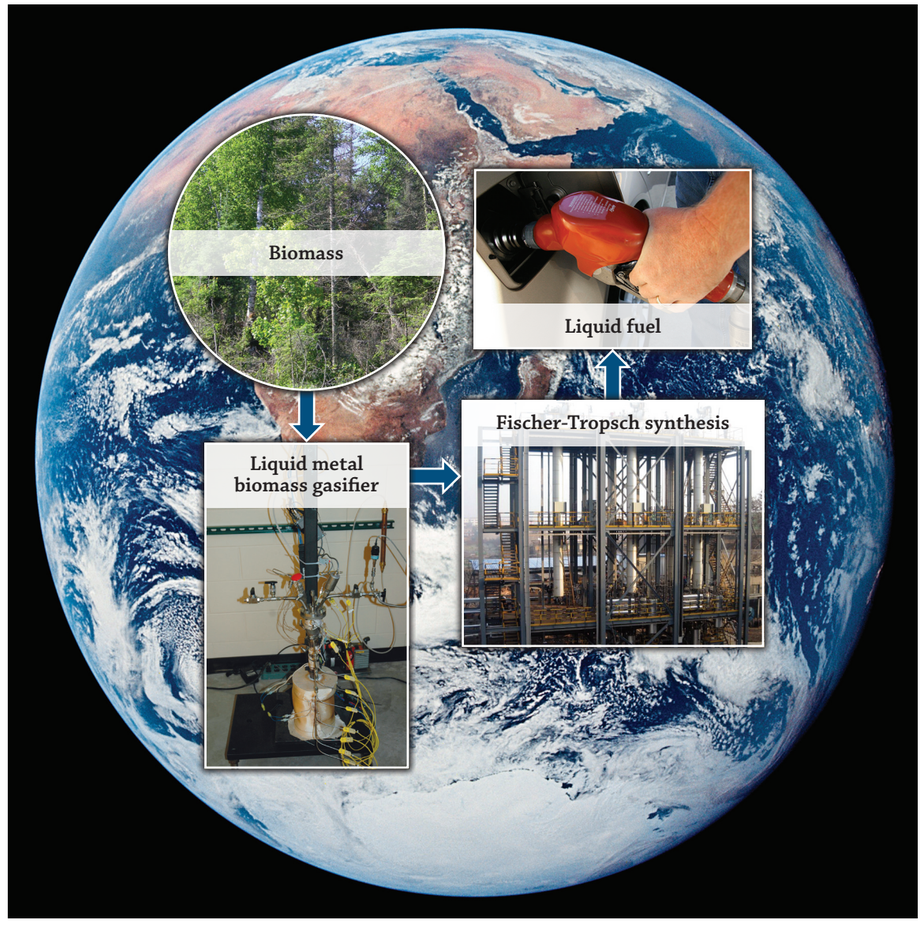
- Utilization of small-diameter timber
- Nanotechnology
- Biorefinery/bioenergy
- Advanced wood structures
- Advanced composites

November 2009

Durability and Wood Protection

Biofuels Advanced Energy Initiative at the Forest Products Laboratory

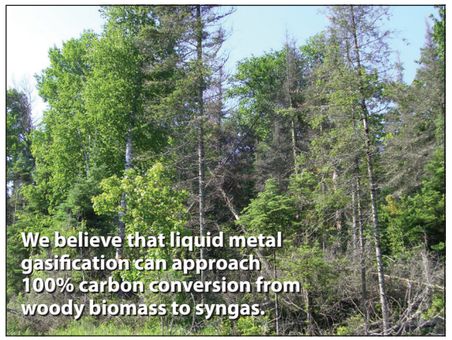
Thermo-Conversion of Woody Biomass

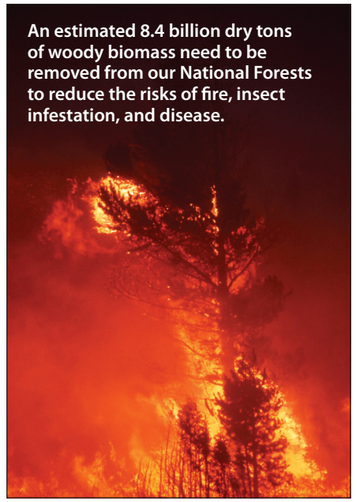


Durability and Wood Protection

Thermo-Conversion of Woody Biomass

A novel liquid metal gasification process is being developed for clean and efficient thermo-conversion of woody biomass into high-yield biofuels. This process can reduce our dependence on fossil fuels, improve forest health, and reduce the risk of wildfires.





Decades of fire suppression have disrupted the natural fire cycle in our National Forests, resulting in dense stands of stunted trees and unnatural, unhealthy accumulations of woody debris. Fires in these overstocked stands are intense and difficult to control and can include crown fires that kill both older trees and otherwise fire-resistant species.

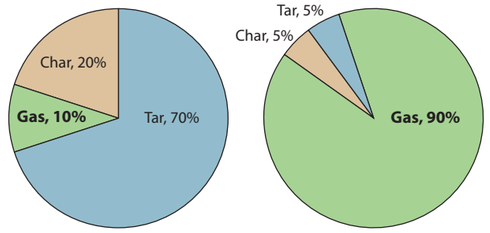
Advantages

Liquid metal gasification of woody biomass addresses some of the disadvantages of biological or chemical conversion processes.

- No need to pre-dry the biomass material, and the moisture can be incorporated in the thermo-conversion process.
- Wide range of sizes.
- Many possible feedstocks.

Another significant advantage of liquid metal gasification is that several steps traditionally done by separate devices—biomass drying, pyrolysis, gasification, and syngas clean-up—can be completed in one unit.

High-yield conversion of wood to energy is dependent on the efficiency of the thermal process.



Low-temperature pyrolysis (typical wood fire)
Low energy output and high residue formation

High-temperature pyrolysis
High energy output and significantly reduced residue formation

A bench-scale gasifier was constructed to prove the concept of high-temperature liquid metal pyrolysis and to conduct initial optimization of temperature and pressure. Pyrolysis was completed in under 3 seconds at 1,000°C and high-quality syngas was produced.

Recent accomplishments

Direct contact molten metal gasification. K.J. Bourne, M.A. Dietenberger, M. Anderson. International Conference on Thermochemical Conversion Science, Sept. 16–18, 2009, Chicago.

Vision of U.S. biofuel future: A case for hydrogen-enriched biomass gasification. M.A. Dietenberger and M. Anderson. Industrial and Engineering Chemistry Research 46:8,863–8,874 (2007).

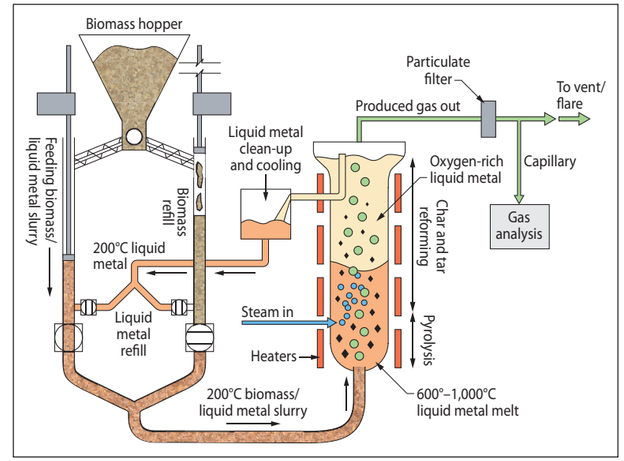
Generic modeling of biorefinery business concept for investment in gasification of wood biomass with syngas to liquids to power. M.A. Dietenberger, P.J. Ince, T.M. Bilek. International Conference on Thermochemical Conversion Science, Sept. 16–18, 2009, Chicago.

Future research

- Optimize parameters: Liquid metal alloy, temperature, pressure, and gas augmentation
- Process scale-up: Develop mobile gasification units that operate at a 1- to 10-MW scale

Outcomes

- Portable gasifiers for use in remote areas to reduce wildfire fuel load
- Conversion of clean syngas to liquid transportation fuel by the Fischer-Tropsch process
- Use of syngas as direct replacement for natural gas and propane



An intermediate-scale closed-loop gasifier is being designed. It will provide the functionalities of a full-scale industrial gasifier, but at a smaller, easily modifiable, and cost-effective scale. For use as a research tool, it will provide a continuous feed capability of up to 7.5 kg/hour, variable feedstock and feed rates, a wide range of process temperatures and pressures, and a full array of measurement capabilities.

Proposed FPL Bioenergy Pilot Plant

The Bioenergy Pilot Plant will enable FPL to address the President's Advanced Energy Initiative designed to reduce America's dependence on foreign sources of energy by meeting the following goals:

- Develop cost-competitive cellulosic ethanol by 2012.
- Produce 20 billion gallons of alternative fuels annually by 2017.
- Replace 75% of our Middle East oil imports with alternative fuels by 2025.
- Meet 30% of our nation's fuel needs with alternative energy sources by 2030.

In addition to thermal conversion, research on microbial and chemical conversion of woody biomass to energy will be conducted in this facility.